cess of this invention enables zinc phosphate treatment to be run very rapidly through the use of electrolysis. This feature, in combination with the fact that this process can be used to execute zinc phosphate treatment on essentially any material that is electrically conductive, makes the instant process highly advantageous on an industrial or commercial basis.

~~CLAIMS~~

1. A liquid composition of matter that is suitable as electrolyte for a nonsludging electrolytic zinc phosphate treatment process, said liquid composition comprising water, dissolved phosphoric acid, dissolved nitric acid, dissolved zinc cations, *m* chemically distinct species of cations other than zinc, and *n* chemically distinct species of anions other than anions derivable by ionization of phosphoric and nitric acids, each of *m* and *n* independently being zero or a positive integer, the concentration of zinc in moles per liter in said liquid composition satisfying the following mathematical condition:

$$\{Zn\} \leq 0.3\,\{H_3PO_4\} + 0.5\,\{HNO_3\} - 0.5\sum_{i=0}^{m} p_i C_i + 0.5\sum_{j=0}^{n} q_j A_j$$

in which: "{Zn}", "$\{H_3PO_4\}$", and "$\{HNO_3\}$" respectively represent the zinc, phosphoric acid, and nitric acid concentrations in mol/L; each of C_0 and A_0 is zero; each of p_0 and q_0 is 1; if *m* is not zero, for each positive integer *i* from 1 to *m*, C_i represents the concentration in mol/L of the *i*'th distinct cation species other than zinc present in the bath and p_i represents the cationic valence of said *i*'th distinct cation species; and if *n* is not zero, for each positive integer *j* from 1 to *n*, A_j represents the concentration in mol/L of the *j*'th distinct anion species other than anions derivable by ionization of phosphoric or nitric acids present in the bath and q_j represents the anionic valence of said *j*'th distinct anion species.

2. A liquid composition according to claim 1, wherein:

- the phosphoric acid concentration is from 0.10 to 0.60 mol/L;
- the nitric acid concentration is from 0.20 to 1.0 mol/L; and
- $\{Zn\} \geq 0.15\,\{H_3PO_4\} + 0.25\,\{HNO_3\} - 0.25\sum_{i=0}^{m} p_i C_i + 0.25\sum_{j=0}^{n} q_j A_j$.

3. A liquid composition according to claim 2, wherein:

- the phosphoric acid concentration is from 0.25 to 0.50 mol/L;
- the nitric acid concentration is from 0.65 to 0.90 mol/L; and
- $\{Zn\} \geq 0.27\,\{H_3PO_4\} + 0.45\,\{HNO_3\} - 0.45\sum_{i=0}^{m} p_i C_i + 0.45\sum_{j=0}^{n} q_j A_j$.

4. A liquid composition according to claim 3, wherein $\{Zn\}/\{H_3PO_4\} < 0.91$.

5. A liquid composition according to claim 2, wherein $\{Zn\}/\{H_3PO_4\} < 0.91$.

6. A liquid composition according to claim 1, wherein $\{Zn\}/\{H_3PO_4\} < 0.91$.

7. A liquid composition according to any one of claims 1 through 6, additionally comprising at least one additive selected from the group consisting of nitrous acid, permanganic acid, peroxysulfuric acid, hydrogen peroxide, chloric acid, perchloric acid, nitrobenzene sulfonic acid, hydroxylamine, starch/phosphoric acid esters, fluorine compounds, and salts of all of the other materials previously recited in this group for which salts are known.

8. A process for forming a zinc phosphate conversion coating on a metal substrate without generating any sludge thereby, said process comprising operations of:

(I) bringing said metal substrate into contact with a volume of a liquid composition according to any one of claims 1 through 7, said volume of liquid composition also being in contact with a counter electrode that is distinct from said metal substrate; and

(II) causing electric current to flow in a cathodizing direction through said metal substrate into said volume of liquid composition and through said counter electrode.

9. A process according to claim 8, wherein:

- said volume of liquid composition is maintained during operation (II) at a temperature that is between 50 and 85 °C; and
- in operation (II) there is a current density through said metal substrate that is between 0.5 and 50 A/dm^2.

10. A process according to claim 9, wherein:

- said volume of liquid composition is maintained during operation (II) at a temperature that is between 75 and 85 °C; and
- in operation (II) there is a current density through said metal substrate that is between 7.0 and 15 A/dm^2.

11. A process according to any one of claims 8 through 10, wherein prior to operation (I), said metal substrate is brought into contact with a weakly basic aqueous colloidal solution that contains titanium oxide, titanium hydroxide, and zinc phosphate.